

AMENDMENT IN THE CLAIMS

Sub Bl 1 ~~1. (Currently Amended) An actuator for providing vibration forces in a haptic feedback device, the actuator comprising:~~

~~a core member, having a central projection; ~~said core member being grounded to a ground member~~;~~

~~a coil wrapped around said central projection of said core member;~~

~~a magnet head positioned so as to provide a gap between said core member and said magnet head, wherein said magnet head is moved in a degree of freedom based on an electromagnetic force caused by a current flowed through said coil; and~~

~~an elastic material positioned disposed in said gap between said magnet head and said core member, wherein said elastic material is compressed and sheared when said magnet head moves and substantially prevents movement of said magnet head past a range limit, said range limit based on an amount to which said elastic material may be compressed and sheared.~~

2 ~~2. (Currently Amended) An actuator as recited in claim 1 wherein said elastic material is comprises foam.~~

3 ~~3. (Currently Amended) An actuator as recited in claim 1 wherein said actuator is driven by a drive signal that causes said magnet head to oscillate and produce a vibration in said ground member further comprising a controller electrically connected to said coil for generating a drive signal.~~

4 ~~4. (Currently Amended) An actuator as recited in claim 1 further comprising at least one flexible member coupled between said magnet head and said ground member, said flexible member flexing to allow said magnet head to move in said degree of freedom a first flexible member attached to said magnet and said core member.~~

- 5 ~~5~~. (Currently Amended) An actuator as recited in claim ~~4~~⁴, ~~further comprising a second flexible member attached to said magnet and to said core member.~~ 1, further comprising:
a ground member attached to said core member; and
a first flexible member attached to said magnet and said ground member.
- 7 ~~6~~. (Currently Amended) An actuator as recited in claim ~~4~~⁴ wherein ~~said at least one flexible member is coupled between said magnet head and a ground surface to a side of said core member.~~ 1, further comprising a first flexible member attached to said magnet and to a grounded surface.
- 8 ~~7~~. (Currently Amended) An actuator as recited in claim ~~4~~⁴ wherein ~~at least one flexible member is coupled to a housing of said actuator.~~ 6, wherein said grounded surface comprises an actuator housing.
- 10 ~~8~~. (Currently Amended) An actuator as recited in claim ~~4~~¹ wherein ~~said degree of freedom of said magnet head is linear.~~ magnet is configured to move linearly.
- 11 ~~9~~. (Currently Amended) An actuator as recited in claim ~~4~~¹ wherein ~~said degree of freedom of said magnet head is rotary, where said magnet head moves in a rotary path.~~ magnet is configured to move rotationally.
- 12 ~~10~~. (Currently Amended) An actuator as recited in claim ~~9~~¹ wherein ~~said core member and said magnet head include curved surfaces to form a curved gap, wherein said elastic material is positioned in said curved gap.~~ 1, wherein:
said core member comprises a first curved surface;
said magnet comprises a second curved surface; and
said elastic material is disposed in a gap formed between said first curved surface and said second curved surface.

16 11. (Currently Amended) An actuator for providing vibration forces in a force feedback device, the actuator comprising:

a core member, ~~said core member being grounded to a ground member~~ having a central projection;

a coil wrapped around a said central projection of ~~said core member~~;

a magnet head positioned adjacent to ~~said core member~~, wherein said magnet head is moved in a degree of freedom based on an electromagnetic force caused by a current flowed through ~~said coil~~ so as to provide a gap between said core member and said magnet; and

at least one flexible member coupled between ~~said magnet head and said ground member~~, said at least one flexible member flexing to allow ~~said magnet head to move in said degree of freedom and providing a centering spring force to said magnet head~~, and wherein said at least one flexible member limits said motion of said magnet head such that said magnet head does not impact a hard surface a first flexible member attached to said core member and said magnet.

17 12. (Currently Amended) An actuator as recited in claim 11 further comprising an elastic material positioned disposed in a said gap provided between ~~said magnet head and said core member~~, wherein said elastic material is compressed and sheared when said magnet head moves and substantially prevents movement of said magnet head past a range limit provided by said elastic material.

19 13. (Currently Amended) An actuator as recited in claim 11 wherein said ~~at least one~~ first flexible member is ~~coupled between~~ attached to said magnet head and a grounded surface to which ~~said core member~~ is coupled.

14. (Cancelled) An actuator as recited in claim 11 wherein said at least one flexible member is coupled between ~~said magnet head and a ground surface to a side of said core member~~.

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15. (Currently Amended) An actuator as recited in claim 13¹⁵ wherein ~~at least one flexible member is coupled to a housing of said actuator~~ said grounded surface comprises an actuator housing.

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16. (Currently Amended) An actuator as recited in claim 11¹⁶ wherein ~~said degree of freedom of said magnet head is linear~~ magnet is configured to move linearly.

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17. (Currently Amended) An actuator as recited in claim 11¹⁶ wherein ~~said degree of freedom of said magnet head is rotary, where said magnet head moves in a rotary path~~ magnet is configured to move rotationally.

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18. (Cancelled) An haptic feedback device coupled to a host computer, said host computer displaying a graphical environment, said haptic feedback device comprising:

a user manipulandum physically contacted by a user and moveable in at least one degree of freedom;

at least one sensor that detects a position of said user manipulandum in said at least one degree of freedom and provides a sensor signal to said host computer, said sensor signal including information representative of said position;

an actuator coupled to said haptic feedback device which outputs a vibration force transmitted to said user, said force correlated with an event or interaction within said graphical environment, wherein said actuator includes:

a core member, said core member being grounded to a ground member;

a coil wrapped around a central projection of said core member;

a magnet head positioned so as to provide a gap between said core member and said magnet head, wherein said magnet head is moved in a degree of freedom based on an electromagnetic force caused by a current flowed through said coil; and

an elastic material positioned in said gap between said magnet head and said core member, wherein said elastic material is compressed and sheared when said magnet head moves

~~and substantially prevents movement of said magnet head past a range limit, said range limit based on an amount to which said elastic material may be compressed and sheared.~~

19. (Cancelled) ~~A haptic feedback device as recited in claim 18 wherein said actuator is coupled to a housing of said haptic feedback device such that said vibration force is transmitted to said user through said housing.~~

20. (Cancelled) ~~A haptic feedback device as recited in claim 18 wherein said degree of freedom is a linear degree of freedom, and wherein said magnet head is oscillated in said linear degree of freedom to provide said vibration force.~~

21. (Cancelled) ~~A haptic feedback device as recited in claim 18 wherein said degree of freedom is a rotary degree of freedom, and wherein said magnet head is oscillated in said rotary degree of freedom to provide said vibration force.~~

22. (Cancelled) ~~A haptic feedback device as recited in claim 18 further comprising at least one flexible member coupled between said magnet head and a ground member of said haptic feedback device, said flexible member flexing to allow said magnet head to move in said degree of freedom.~~

23. (Cancelled) ~~A haptic feedback device as recited in claim 18 wherein said haptic feedback device is a gamepad controller and said user manipulandum is a joystick moveable in two degrees of freedom.~~

9 24. (New) An actuator as recited in claim 4 wherein said first flexible member is attached to said magnet head and a ground surface.

6 ~~25~~ (New) ⁵ An actuator as recited in claim ~~5~~, further comprising a second flexible member attached to said magnet and said ground member.

18 ~~26~~ (New) ¹⁷ An actuator as recited in claim ~~12~~, wherein said elastic material comprises foam.

21 ~~27~~ (New) ¹⁹ An actuator as recited in claim ~~13~~, further comprising a controller electrically connected to said coil for generating a drive signal.

22 ~~28~~ (New) ¹⁹ An actuator as recited in claim ~~13~~, further comprising a second flexible member attached to said magnet and said core member.

ai 23 ~~29~~ (New) ¹⁹ An actuator as recited in claim ~~13~~, wherein:
said core member comprises a first curved surface;
said magnet comprises a second curved surface.

24 ~~30~~ (New) ²³ An actuator as recited in claim ~~29~~, further comprising an elastic material positioned in a gap formed between said first curved surface and said second curved surface.

29 ~~31~~ (New) An actuator comprising:
a core member, having a central projection;
a coil wrapped around said central projection;
a magnet positioned so as to provide a gap between said core member and said magnet;
and
a ground member attached to said core member; and
a first flexible member attached to said magnet and said ground member.

30 ~~32~~ (New) ²⁹ An actuator as recited in claim ~~31~~, further comprising a second flexible member attached to said magnet and said ground member.

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31 ~~33~~. (New) An actuator as recited in claim 31, wherein said ground member comprises a grounded surface.

32 ~~34~~. (New) An actuator as recited in claim 34, wherein said grounded surface comprises a surface of a housing. 35 31-

13 ~~35~~. (New) A device comprising:
a manipulandum having a housing; and
an actuator as recited in claim 1 coupled to said manipulandum and disposed within said housing.

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14 ~~36~~. (New) A device as recited in claim 35, wherein said manipulandum comprises a joystick. 13

27 ~~37~~. (New) A device comprising:
a manipulandum having a housing; and
an actuator as recited in claim 11 coupled to said manipulandum and disposed within said housing. 16

28 ~~38~~. (New) A device as recited in claim 37, wherein said manipulandum comprises a joystick. 27

15 ~~39~~. (New) An actuator as recited in claim 1 wherein the elastic material is configured to restrict a range of motion of the magnet or the core member. 1